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Notes on *Isoetes riparia* and *Isoetes saccharata*.

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DISTRIBUTION.—In the middle states both these species are accounted quite local. Farther north *I. riparia* Engelm. is recorded as coming from several places, but south of New England it is apparently confined to the tidal shores of the Delaware river.¹ So far as known, *I. saccharata* Engelm. is still more restricted in its range; and, in fact, it had been, until quite lately, collected only by Wm. M. Canby, its discoverer, within quite circumscribed areas on the two neighboring Chesapeake rivers, Wicomico and Nanticoke, where it was first seen in 1863.

The writer has had the good fortune to find, during the last three years, in a number of coves and creeks about eighty miles farther north, a series of forms which, though departing in cases a good deal from the type, seem referable to *I. saccharata* Engelm., and to it only. These new stations are in Sassafras and Elk rivers, which are in effect broad, short arms of Chesapeake bay near its head, piercing the hilly "eastern shore" of Maryland.

The Back creek station, in Elk river, is within two miles of the Delaware and Chesapeake canal at its western end; and within perhaps seven miles of the eastern end of the same canal, on the Delaware river, grows *I. riparia*. Near relatives these two species have long been known to be. Now they are found to be near neighbors as well.

TYPE CHARACTERS.—Dr. Engelmann's descriptions have fixed these, and in order that the ensuing notes may not lack in clearness, they are here reproduced in full.²

I. saccharata Engelm.—A small plant, usually with a flat, depressed trunk; leaves subulate, olive green, spreading, ten to twenty in number, two to three inches long; sporangium spotted, oblong, with narrow velum; ligula triangular; macrospores 0.40 to 0.47^{mm} thick, covered with very minute distinct or sometimes a little confluent warts; microspores papillose, 0.024 to 0.028^{mm} long.

¹ Engelmann: Trans. St. Louis Acad. Sci. 4: 382.

² Engelmann: loc. cit.

I. riparia Engelm.—A larger plant with slender but rather rigid deep green leaves (about fifteen to thirty in number) four to eight inches long, rarely longer; stomata numerous, dissepiments thick, consisting of about four layers of cells; sporangium mostly oblong, distinctly spotted by groups of brown sclerenchym cells, one-fourth or rarely one-third of it covered by the velum; macrospores among the largest, 0.45 to 0.65^{mm} in diam., marked with jagged crests isolated or anastomosing especially on the lower surface, which thus becomes somewhat reticulated; microspores more or less tuberculated, 0.028 to 0.032^{mm} long.

It is to be remarked that few hard and fast contrasts are established in the above descriptions. A difference of color, a larger size, a larger number of leaves are not such items as will help greatly to determine the allegiance of any doubtful plant in hand. Spore characters alone seem definite. (The relative sizes of the microspores are made a good deal of by Dr. Engelmann.) The sporangia of both are spotted, though a kind of distinction is for some reason attempted in Gray's Manual, 6th edition, where the sporangium of *I. saccharata* is stated to be "nearly unspotted."

Biologically, so far as known and studied, the two species have been thought quite similar.

VARIATIONS.—*I. riparia*. My acquaintance with this species, as it occurs on the Delaware near Chester, Pa., and immediately opposite on the New Jersey shore, extends over several years. It confines itself to clay-gravel tidal banks which are capped either with mud or fibrous growths that prevent the spores being washed away by the storm-tides. A large number of plants gathered in August, 1894, showed a majority with all mature leaves decidedly longer than the limit given. The usual, not the occasional, length was nine and three-fourths to ten inches. The color was dark green. The bulb or crown, when carefully measured, was found to be one-half to five-eighths of an inch in diameter. The sporangia were oblong, 4 to 5^{mm} long. The velum covered two-thirds to three-fourths of the sporangium, instead of but one-third. The macrospores were of the usual size, 0.50 to 0.63^{mm}, with the ridges quite jagged, and more or less reticulated. While gathering these plants I noticed many, only to reject them, which seemed to have lost their outer leaves, for they bore no macrosporangia. Only those plants were collected,

the bulbs of which were obviously swollen with mature macrospores. The gathering was not studied closely until winter. So it comes that I cannot here give measurements of microspores; but in place of doing so, I have to announce that *I. riparia* is polygamous.

All the plants collected in August were found to bear mature macrospores all the way to the center. The whole gathering, minus a quantity pressed and sent away for exchanges, consisted of about twenty-five plants. It afforded not a single microsporangium. Only two or three immature leaves in the center of each plant were without spores of any kind. The number of leaves was as large as usual, and in some cases larger.

In August and September of 1895, in the same place, many plants were found with only two or three macrosporangia, others without any, and others with macrosporangia only. Six duplicates, remaining from a collection in 1890 (September) much smaller than the above, but still *I. riparia*, yielded but a single microsporangium, while macrospores, mature and immature, extended all the way to the center. Two plants collected at Pennsgrove, N. J., August 23, 1895, were likewise entirely female, though quite mature. These were of another outer aspect, but the spores showed them to be *I. riparia*. The leaves were of a dull green, five inches long, widely spreading. The crown measured five-eighths of an inch, the sporangium about 7^{mm}. Macrospores were 0.51 to 0.58^{mm} thick, irregular and distorted in shape, and covered with such a mass of crowded and crested ridges as to hide completely the surface proper. The rims of suture and the rim between the hemispheres were also jagged and quite remarkably high. The velum was broad, covering three-fourths of the sporangium. These plants approached some forms of *I. saccharata* in aspect.

Some smaller plants, collected in August, 1895, near Chester, rather darker green in color, were monoecious. The leaves are but four to four and one-half inches long, somewhat spreading; sporangium ovoid; velum quite narrow to one-third the sporangium; macrospores 0.38 to 0.47^{mm} and marked much as in some forms of *I. saccharata*. In fact, these spores, and those from some Chesapeake plants, do not admit of distinguishing descriptions.

The microspores of *I. riparia* vary, by actual measure-

ment, from 0.026 to 0.030^{mm}. The "tubercles" with which they are beset are more plentiful, and so more obvious than the papillæ of the other species, but scarcely differ from them in appearance.

I. saccharata. The structural variation here is apparently greater than in the other species, while any dioecious tendency is still to be detected. Plants were collected at the original station on Wicomico river, Sept. 14, 1895, where they grow plentifully in sand deeply overlaid with mud. These agree, for the most part, with the description of Engelman. But the leaves of mature plants are generally three to five inches long, and the macrospores 0.48 to 0.55^{mm} thick, with warts a good deal confluent, especially below, but not reticulated. The microspores measure 0.024 to 0.028^{mm} long. The olive green color, the rather flaccid state of the leaves, and the constant narrow velum were sufficiently noticeable. The whole plant, though taller than one would expect, is of quite slight build. The trunk is very small.

In 1895 I noted³ the collection of this species in Elk river, at Piney creek cove and Back creek. In August of the same year it was observed in other places in the same river. As it appears there, it is a more robust plant than on the Wicomico. The leaves are somewhat stiffer, of a deeper green, and of a nearly uniform length of three to three and one-half inches. Though less flaccid, they are generally strongly curved, and their ends mostly rest upon the ground. The crown measures one-half to three-fourths inch in diameter; the macrospores are 0.40 to 0.48^{mm} thick, with warts but little confluent above, blunt and not at all crested. The microspores are 0.028 to 0.030^{mm} long, quite as long as those of *I. riparia*, but less plentifully knobbed than the latter. The velum varies but little, never reaching more than one-fourth the sporangium. The sporangium is sometimes 5^{mm} long, while that of the Wicomico plants is at most 3.5^{mm}. The trunk is not different from the typical trunk of the species.

On August 12, 1895, two more forms of the species, which further study may show to be worthy of distinction as varieties, were collected in Lloyd's creek, Sassafras river. The first of these, the most robust form of the species yet observed, has almost precisely the general aspect of the *I. riparia* collected at Pennsgrove, N. J., and described above. It

³BOTANICAL GAZETTE, 20: 32. Ja. 1895.

has stiffish, strongly curved leaves, rather dark green in color, 4 to 6 inches long. The crown measures one-half to one inch in diameter. The macrospores are 0.51 to 0.55^{mm} thick, marked with somewhat crested warts, higher and more confluent into twisted ridges than in the Wicomico plants. The microspores are 0.026 to 0.028^{mm} long. The velum is narrow. The sporangium is 6 to 7^{mm} in length, very long and slim. The microsporangium has much the same shape as in *I. Engelmanni* var. *valida*. This form was plentifully planted in rather coarse gravel, overlaid with a shallow mud.

Close beside, in densely compacted masses, grew the second form. The leaves are about the same darkish green, 8 to 9 inches long, and remarkable for the number and size of their stomata. These leaves spread less widely than in the form next preceding. The crown is about one-half inch in diameter. The macrospores are 0.51 to 0.53^{mm} thick, with warts quite crowded and confluent into twisted ridges below, sometimes a little reticulated; above, the ridges are somewhat parallel; and in general the markings may be said to differ markedly, in both these Lloyd's creek forms, from the type. Microspores are 0.024 to 0.032^{mm} long. The sporangia are about 7^{mm} long when longest. The velum is narrow.

In color, size of sporangium, and general outward aspect the two Lloyd's creek forms vary in a notable manner from the *Isoetes saccharata* type of Engelmann. This variation is in the direction of *I. riparia* as it presents itself in the plants collected at Pennsgrove, N. J. and above described. The macrospores are of an approximately equal size. But here the resemblance ends; for the macrospores of the Pennsgrove plants are, as stated, quite peculiarly deeply ridged, even for *I. riparia*; the velum is unusually broad; the habit is dioecious.

On the other hand, the small forms of *I. riparia* noted above, from Chester, Pa., vary in spore characters toward the Lloyd's creek plants, to such an extent that if such characters alone could settle the question, the two would have to be classed together. Yet here, as is the former case, the velum is often broader than in any known form of *I. saccharata*.

My study of these two species is as yet incomplete, and final conclusions as to their relations are scarcely permissible. The foregoing notes must make it evident that distinctive structural characters are less numerous even than would ap-

pear from Engelmann's account. Yet there appears to be an unmistakable specific distinction. The widely varying velum of *I. riparia* (from quite narrow to three-fourths the sporangium), and its spores differing so remarkably in size and markings, as well as the varying habit of growth and gradations of color; and the wide departures from the type in point of size, color and spore characters in *I. saccharata* may well cause doubt at times as to individual plants. But the narrow velum of the latter seems to be a constant feature, while in *I. riparia* it varies from leaf to leaf of the same plant. This single definite character, constant in the most aberrant forms, seems to me to gather significance as other characters vary, until it becomes as it were a touchstone. Moreover, until dioecious tendencies are made out in *I. saccharata* there is good reason for specific distinction.

Media, Pa.